AGE OF FRACTURING AND MESA DEVELOPMENT IN THE ELYSIUM AREA, NORTHERN MARTIAN PLAINS

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One of the fundamental questions of martian crustal history is the origin of the crustal dichotomy between northern plains and southern highlands (cf. Wise et al., 1979; Wilhelms and Squyres, 1984). Hypotheses for the origin of this dichotomy may be constrained by global-scale, geophysical considerations, or by detailed geological studies of the genesis and relative ages of materials and landforms in the northern plains of Mars and along the boundary between the plains and the highlands. This abstract summarizes progress on one aspect of a long-range geological study intended to constrain hypotheses for the dichotomy by tracing the history of the northern plains from the most recent events backward -- essentially the same approach used to understand old events in Earth history.

Both the giant impact and the mantle convection models for the crustal dichotomy imply a major coeval fracturing event. As has been known for some time (Scott, 1978; Hiller and Neukum, 1978; Maxwell et al., 1984), the present dichotomy boundary lies well south of its original position, at least in some places. Nevertheless, there is severe fracturing of this present dichotomy boundary in many places. The specific objectives of this portion of the study are to determine the age(s) of fracturing along the present dichotomy boundary, and to determine when the abundant knobs and mesas scattered over much of the northern plains were formed or emplaced.

The work summarized here includes detailed mapping of portions of Elysium Mons and adjacent plains using 1:500,000 USGS MTM quadrangles, and crater dating of materials, surfaces, and fracturing events. For the crater dating, the production curve of Neukum (1983) has been used in order to state all ages in terms of cumulative number of craters greater than 1 km in diameter per million square kilometers. Neukum's 1983 curve fits the crater plots better than his earlier curve (Neukum and Hiller, 1981), and produces ages for older surfaces more in line with those reported by other workers.

Careful mapping of the northern boundary region between Elysium Mons and adjacent plains indicates that there is no consistently mappable contact between the lava flows of Elysium Mons and the plateau material faulted into the spectacular fretted terrain along its north edge, nor between this plateau material and the material capping the mesas immediately to the north of the fretted terrain. Furthermore, no consistently mappable contact can be defined between plateau and mesa caprock and the materials within the troughs of the fretted terrain. The youngest Elysium lavas occur as clearly defined lobate flows, two or three of which are obviously cut by faults of the fretted terrain. These relationships imply that the plateau and mesa caprocks are lavas related to Elysium Mons volcanism, and that the faulting responsible for the fretted terrain is younger than these flows. A crater count on the northern flank of Elysium Mons, immediately upslope from the fretted terrain, yields a 1-km crater age of 3,800. This is a composite age, because it is obvious that the flows on the flank of Elysium Mons are not all the same age. Because the youngest, lobate flows cover only a small part of the counting area, and because they are too thin to obliterate the craters used to date the surface (>1.5 km in diameter), the crater age obtained is a good estimate of the age of the older and smoother surface beneath the young flow lobes; it is this surface that is apparently continuous with the fretted plateau surface and the caprock of the mesas to the north. Clearly, the faulting responsible for the formation of the fretted terrain must be younger than this surface, and thus must be younger than crater age 3,800. Because some of the youngest flow lobes are cut by faults, this faulting could be significantly younger than 3,800.

North of the fretted terrain is a complex plains surface with at least three mappable material units intimately interspersed, and with numerous mesas scattered about. A small proportion of the plains consists of a smooth-surfaced material that occupies topographic lows and that appears much younger than the other types of plains materials. The other plains materials appear to be the same age, and the crater age for these is 2,900.

The scattered mesas on the northern plains were in place as discrete, isolated landforms before the intervening plains units formed. Wherever the relationships are resolvable on the images, the mesas are older than the craters used to define the 2,900 age: ejecta rest on top of mesas, and mesas interfere with the flow of ejecta from splosh craters. In the east-central part of the MTM 35212 1:500,000 quadrangle are curious, winding ridges that lie in shallow, broad depressions between what appear to be simple flood flows. Here, the mesas are concentrated in these depressions, commonly occuring in sinuous lines connected by ridges. Commonly, the winding ridges appear to pass beneath mesas, but locally they clearly cut them. In places, winding ridges can be seen to change along trend into open fractures, and these clearly cut mesas. The age implications are that the mesas are older than both the winding ridges and the flood lavas that are the local surface unit of the plains. It seems likely that the depressions between the young flood flows represent topographically high, unflooded places on the underlying surface. These highs may well represent the residual elevations left from the erosion of the older plateau surface now represented only by the surviving mesas. This peculiar topography suggests that the original "plateau" may not have been continuous, but may instead have consisted of discrete lobes with low areas between them.

Two interesting results are emerging from this study:

1) The plateau in the Elysium area that now survives as fretted terrain and isolated mesas was genetically linked to volcanism from the Elysium Mons area. This plateau was faulted and eroded into fretted terrain and isolated mesas during a very short time interval following its formation (later than crater age 3,800 and before crater age 2,900).

2) Most of the isolated topographic features projecting through the plains north of Elysium Mons (and apparently elsewehere in the northern plains as well) are better described as knobs than as mesas. In places, these knobs can be shown to represent remnants of ancient highland crust (McCauley et al., 1972; Carr et al., 1973; McGill, 1986); thus they are clearly different from mesas, and they need not be due to the major erosional event between crater ages 3,800 and 2,900 that appears responsible for the development of mesas. This in addition to evidence cited above for a lobate rather than continuous original distribution of the "plateau" precursor to the mesas indicates that the volume of material removed from the northern plains during erosion between crater ages 3,800 and 2,900 may be more manageable than once feared; in fact, most of it may not have been removed at all, but may lie beneath the young lava flows now covering the plains surface between the mesas. It should be noted that these results stem primarily from work in the Elysium area; their validity for other parts of the northern plains remains to be demonstrated. Finally, the possible elimination of the "volume problem" for late erosion in the northern plains area does not solve the even greater volume problem inherent in the low elevation of the northern third of Mars.

<u>References</u>

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